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Sains Humanika

Assessing Preservice Teachers' Knowledge of Area

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Abstract

This paper attempts to assess pre service teachers' knowledge of area. In this study, the researchers employed survey research design to assess pre service teachers' knowledge of area. A set of questionnaire was employed to collect the data. Convenient sampling technique was employed to select the participants of the study. Respondents of the study consisted of 46 pre service teachers (majored or minored in mathematics) who are attending Bachelor of Science with Education program at a public university in Peninsula Malaysia. This paper presents the analysis of the responses of the pre service teachers related to a particular mathematical task, namely notion of area. The finding suggests that 78.26% of the pre service teachers in this study had successfully selected all the shapes that have an area. They had the correct notion of area that 2-dimensional shapes (closed plane shapes) and 3-dimensional shapes. Different categories of incorrect notion of area were identified. Implications of the findings were also discussed.

Keywords: Pre service teachers; knowledge of area; survey research design; convenient sampling technique

Abstrak

Kajian ini cuba untuk menilai bidang pengetahuan guru pelatih. Dalam kajian ini, para penyelidik menggunakan rekabentuk kaedah tinjauan untuk menilai bidang pengetahuan guru pelatih. Satu set soal selidik telah digunakan untuk mengumpul data. Teknik persampelan mudah telah digunakan untuk memilih peserta kajian. Responden kajian ini terdiri daripada 46 orang guru pelatih (mengambil jurusan major atau minor dalam matematik) yang mengambil program Sarjana Muda Sains dengan Pendidikan di sebuah universiti awam di Semenanjung Malaysia. Kajian ini melaporkan analisis jawapan daripada guru-guru pelatih yang berkaitan dengan tugasan matematik khususnya, iaitu konsep luas. Dapatan kajian menunjukkan bahawa 78.26 % daripada guru-guru pelatih dalam kajian ini telah berjaya memilih semua bentuk yang mempunyai luas. Mereka mempunyai tanggapan yang betul bagi luas yang berbentuk 2-dimensi (bentuk kapal terbang tertutup) dan bentuk 3-dimensi. Kategori berbeza bagi tanggapan yang tidak betul adalah dikenal pasti. Implikasi daripada dapatan juga telah dibincangkan.

Kata kunci: Guru pelatih; luas kawasan; reka bentuk kajian tinjauan; teknik persampelan mudah

1.0 INTRODUCTION

One cannot teach what one does not know. Teachers must have in-depth knowledge of the subject they are going to teach. Fennema and Franke (1992) advocated that "No one questions the idea that what a teacher know is one of the most important influences on what is done in classroom and ultimately on what students learn" (p. 147). Furthermore, "Teachers who do not themselves know a subject well are not likely to help students learn this content." (Ball, Thames, & Phelps, 2008, p. 404). This applies also to pre service teachers. This paper attempts to assess pre service teachers' knowledge of a specific mathematical topic, namely perimeter and area, in particular, on the notion of area.

1.1 Notion of Area

Numerous definitions of area were provided by the researchers or mathematics educators. Table 1 shows some of these definitions. Martin and Strutchens (2000) noted that "The concept of area is often difficult for students to understand, perhaps due to their initial experiences in which it is tied to a formula (such as area = length × width) rather than more conceptual activities such as counting the number of square units it would take to cover a surface" (p. 223). Cavanagh (2008) found that 53% of the 43 Year 7 students from two government high schools in Sydney in his study defined area as 'space inside the shape' while 19% referred it as 'length by width'. However, Tierney, Boyd, and Davis (1990) revealed that many prospective primary school teachers from a teachers college in their study thought that area is 'length by width'. When the prospective teachers were asked what they would teach a ten year old child about area, "80% of them drew a rectangle and wrote "$l \times w$" or "l by w" near it. Some of these students (prospective teachers) placed arrows around a rectangle in a way which denoted perimeter rather than area" (pp. 307-308). The remaining 20% of prospective teachers defined area as the space inside a figure. Furthermore, Casa, Spinelli, and Gavin (2006) noticed that many adults thought that area is 'length by width'. "They understand

area as a formula rather than as a concept - the amount of space covered by the inside boundaries of a two-dimensional figure" (Casa *et al*., 2006, p. 168).

Table 1 List of definition of area

Some of the definitions of area

Researchers or mathematics educators	Definition of area
Ball, 1988, p. 170.	The area is the number of unit squares it takes to cover the figure or region.
Bennett & Nelson, 2001, p. 653.	The number of units it takes to cover a surface (or region) is called its area.
Billstein, Liberskind, & Lott, 2006, p. 750.	Area of a region is the number of non overlapping square units that covers the region.
Cathcart, Pothier, Vance, & Bezuk, 2006, p. 330.	Area is the amount of surface enclosed by a curve in the plane.
Haylock, 2001, p. 268.	Area is a measure of the amount of two-dimensional space inside a boundary.
Long & DeTemple, 2003, p. 771.	The number of units required to cover a region in the plane is the area of the region.
Rickard, 1996, p. 306.	Area is represented as the number of square units needed to cover a shape.
Suggate, Davis, & Goulding, 1999, p. 134.	Area-amount of surface.

Baturo and Nason (1996) suggested that area can be viewed from two different perspectives, namely static and dynamic perspectives. From the static perspective, area can be viewed as the amount of surface enclosed within a boundary. If a pre service teacher selected one or more open shapes and explained that the shape(s) had an area of zero, then it indicated that the pre service teacher is having a dynamic perspective of area. Baturo and Nason (1996) found that none of the 13 pre service primary school teachers in their study selected open shapes (including the lines) as having an area. It can be inferred that they did not have a dynamic perspective of the notion of area. Furthermore, all of them indicated that these shapes (i.e., open shapes) needed to be closed showing that they had a static perspective of the notion of area. Baturo and Nason (1996) also found that three of the pre service teachers in their study appeared to associate the notion of area with the measurement of area (i.e., area does not exist until it is measured).

Wun (2010) revealed that half of the eight pre service secondary school mathematics teachers in his study had the correct notion of area that 2-dimensional shapes and 3-dimensional shapes have an area. Finding of Wun and Lim (2011) suggested that 36% of the pre service special education teachers in their study had the correct notion of area that 2-dimensional shapes (closed plane shapes) and 3-dimensional shapes have an area. Review of research literature had also shown that some students and pre service teachers encountered difficulty in differentiating between the attributes of perimeter, area, and volume (Baturo & Nason, 1996; Beaumont, Curtis, & Smart, 1986; Ramakrishnan, 1998; Reinke, 1997; Wun, 2010; Wun & Lim, 2011).

■2.0 CONCEPTUAL FRAMEWORK

Nik Azis (1996) suggested that there are five basic types of knowledge, namely conceptual knowledge, procedural knowledge, linguistic knowledge, strategic knowledge, and ethical knowledge. In the present study, the researchers have adapted Nik Azis's (1996) categorization of knowledge to assess pre service teachers' knowledge of area.

■3.0 METHODOLOGY

In this study, the researchers employed survey research design to assess pre service teachers' knowledge of area. Convenient sampling technique was employed to select the participants of the study. Respondents of the study consisted of 46 pre service teachers (majored or minored in mathematics) who are attending Bachelor of Science with Education program at a public university in Peninsula Malaysia.

This paper reports only the responses of the participants on Task 1.2 (see Appendix A). This task was adapted from previous study (Baturo & Nason, 1996, p. 245). In Task 1.2, the respondents were asked to select the shapes (12 shapes) that have an area. The objective of this task was to determine the participants' conceptual knowledge about the notion of area. Six 2-dimensional shapes (A, C, D, H, I, K) were used to ascertain whether the respondents understood area from a static perspective. Based on this perspective, "area can be considered as the amount of surface enclosed within a boundary" (Baturo & Nason, 1996, p. 245). Two open shapes (B, G) were included to investigate further the participants' understanding of the notion of area from a static perspective.

Two 1-dimensional shapes (E, L) were included to ascertain whether the respondents understood area from a dynamic perspective. If the participants selected one or both of these shapes and explained that the shape(s) had an area of zero, then this response indicated that the respondents are having a dynamic perspective of area (Baturo & Nason, 1996). Finally, two 3-dimensional shapes (F, J) were included because review of research literature had shown that some students and pre service teachers encountered difficulty in differentiating between the attributes of perimeter, area and volume (Baturo & Nason, 1996; Beaumont, Curtis, & Smart, 1986; Ramakrishnan, 1998; Reinke, 1997; Wun, 2010; Wun & Lim, 2011).

Task 1.2 was also used to determine the participants' linguistic knowledge of area based on the language of mathematics (such as mathematical terms and symbols) that the subjects used to justify the selection of shapes that have an area. There are some good behaviors that the respondents needed to follow when dealing with area. Knowledge and justification of knowledge is an important aspect in any discipline. Thus, this task was also used to determine the participants' ethical knowledge of area by ascertaining whether the respondents justify the selection of shapes that have an area.

A set of questionnaire was employed to collect the data. The questionnaire was administered to all the pre service teachers (majored or minored in mathematics) who are attending Bachelor of Science with Education program at a public university in Peninsula Malaysia.

■4.0 FINDINGS OF THE STUDY

In this section, findings of preservice teachers' knowledge of area were presented in terms of its components as stipulated in the previous section.

4.1 Conceptual Knowledge

The finding suggests that 78.26% of the pre service teachers in this study have successfully selected all the shapes that have an area. They had the correct notion of area that 2-dimensional shapes (closed plane shapes) and 3-dimensional shapes have an area. The distribution and percentage of respondents' selection of shapes that have an area and their notion of area is shown in Table 2.

Table 2 Distribution and percentage of respondents' selection of shapes that has an area and their notion of area

Table 2

Distribution and Percentage of Respondents' Selection of Shapes That Has an Area and Their Notion of Area

Selection of shapes that have an area	Notion of area	Number of respondents	Percentage of respondents
A, C, D, F, H, I, J, K	2-dimensional shapes and 3-dimensional shapes	36	78.26
A, C, F, H, J	Limited to regular 2-dimensional shapes (such as triangle, circle, and trapezium) and 3-dimensional shapes	8	17.39
A, C, D, F, H, J	Limited to regular 2-dimensional shapes (such as triangle, circle, and trapezium) and 3-dimensional shapes	1	2.17
A, C, F, J	Limited to triangle, circle, and 3-dimensional shapes	1	2.17

Nevertheless, 19.56% of the pre service teachers had the incorrect notion of area that only regular 2-dimensional shapes (such as triangle, circle, and trapezium) and 3-dimensional shapes have an area. One of the pre service teachers (i.e., 2.17%) had the incorrect notion of area that only triangle, circle, and 3-dimensional shapes have an area.

The finding suggests that all the pre service teachers in this study did not select the two 1-dimensional shapes (E, L) that do not have an area. It can be inferred that all of them did not have a dynamic perspective of area or this knowledge was not accessible to them during the survey. It revealed that all the pre service teachers in this study have a static perspective of area.

4.2 Linguistic Knowledge

When asked to justify their selection of shapes that have an area, the finding suggests that 84.78% of the pre service teachers in this study used appropriate mathematical terms to justify their selection of shapes that have an area. Specifically, 60.87% of the pre service teachers employed appropriate mathematical term 'closed shape' to justify their selection of shapes that have an area. 13.04% of the pre service teachers used appropriate mathematical term 'calculate' (i.e., can be calculated) to justify their selection of shapes that have an area. It indicated that they appeared to associate the notion of area with the measurement of area (i.e., area does not exist until it is measured).
4.35% of the pre service teachers employed appropriate mathematical terms 'enclosed shape' and 'bounded shape' to justify their selection of shapes that have an area respectively. 2.17% of the pre service teachers used appropriate mathematical term 'measure' (i.e., can be measured) to justify their selection of shapes that have an area respectively. It indicated that they appeared to associate the notion of area with the measurement of area (i.e., area does not exist until it is measured). The distribution and percentage of respondents' justification for the selection of shapes that have an area is depicted in Table 3.

The finding suggests that 10.87% of the pre service teachers in this study used inappropriate words to justify their selection of shapes that have an area. Specifically, 2.17% of the pre service teachers used inappropriate words 'line joins together', 'lines meet', 'complete shape', 'complete diagram', and 'fixed structure' to justify their selection of shapes that have an area respectively. Table 3 demonstrated that only 4.35% of the pre service teachers in this study did not provide any justification for their selection of shapes that have an area.

4.3 Ethical Knowledge

Knowledge and justification of knowledge is an important aspect in any discipline. The finding suggests that 95.65% of the pre service teachers in this study had taken the effort to justify the selection of shapes that have an area. Nevertheless, as reported in the previous

section, 84.78% of the pre service teachers in this study provided appropriate justification for their selection of shapes that have an area while 10.87% of the pre service teachers provided inappropriate justification for their selection of shapes that have an area. The remaining 4.35% of the pre service teachers did not provide any justification for their selection of shapes that have an area.

Table 3 Distribution and percentage of respondents' justification for the selection of shapes that has an area

Table 3

Distribution and Percentage of Respondents' Justification for the Selection of Shapes That Has an Area

Justification for the selection of shapes that have an area	Number of respondents	Percentage of respondents
Appropriate		
Closed shape	28	60.87
Can be calculated	6	13.04
Enclosed shape	2	4.35
Bounded shape	2	4.35
Can be measured	1	2.17
Inappropriate		
Line joins together	1	2.17
Lines meet	1	2.17
Complete shape	1	2.17
Complete diagram	1	2.17
Fixed structure	1	2.17
No justification		
Did not provide any justification	2	4.35

■5.0 CONCLUSION

In conclusion, 78.26% of the pre service teachers in this study had the correct notion of area that 2-dimensional shapes and 3-dimensional shapes have an area. This finding is in contrast with the finding of Wun' (2010) study which found that half of the eight pre service secondary school mathematics teachers in his study had the correct notion of area that 2-dimensional shapes and 3-dimensional shapes have an area. This finding is also in contrast with the finding of Wun and Lim' (2011) study which suggested that 36% of the pre service special education teachers in their study had the correct notion of area that 2-dimensional shapes (closed plane shapes) and 3-dimensional shapes have an area. 84.78% of the pre service teachers in this study used appropriate mathematical terms to justify their selection of shapes that have an area. 95.65% of the pre service teachers in this study had taken the effort to justify the selection of shapes that have an area.

The implication of this finding is that mathematics educators as well as mathematics teacher educators need to organize teaching and learning activities that provide opportunity for their students and pre service teachers to investigate examples and non examples of shapes that have and do not have an area. They included open shapes, 1-dimensional shapes, 2- dimensional shapes, and 3-dimensional shapes because previous studies had shown that some students and pre service teachers encountered difficulty in differentiating between the attributes of perimeter, area, and volume (Baturo & Nason, 1996; Beaumont, Curtis, & Smart, 1986; Ramakrishnan, 1998; Reinke, 1997; Wun, 2010; Wun & Lim, 2011).

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